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Cameraless Peritoneal Entry in Abdominal Laparoscopy

William H. Carlson, MD, Griffeth Tully, MD, Amit Rajguru, MD, Dan R. Burnett, MD, Ricardo A. Rendon, MD

ABSTRACT

Background and Objectives: Despite significant advances in laparoscopic instrumentation and techniques, injury to intraabdominal structures remains a potentially serious complication of peritoneal access. Consensus on the best method to obtain peritoneal access is lacking. A safe technique that does not rely on direct visualization of the abdominal layers could shorten the learning curve for surgeons and potentially be adopted by other physicians for a variety of nonsurgical indications for peritoneal entry.

Methods: A prospective series of 99 consecutive patients who underwent upper-abdominal laparoscopic surgery performed by a single surgeon between January 2009 and June 2010 was reviewed. The method used to obtain peritoneal access was the fluid-based peritoneal entry indication technique (C-PET) with the EndoTIP trocar.

Results: Successful abdominal entry using C-PET was achieved in 90 (90.9%) of the patients; no trocar-related injuries or other injuries associated with peritoneal access occurred. The mean time from incision to confirmed peritoneal access was 21.4 s (range, 12 to 65). Of the 9 cases in which C-PET did not successfully gain entry, 6 occurred during the first 20 surgeries and only 3 in the final 79.

Conclusions: C-PET is simple, safe, timely, and effective for gaining peritoneal access during laparoscopic abdominal surgeries. In this series, C-PET produced no complications and proved effective across a wide variety of patients, including the obese and those who had had previous surgery. Furthermore, C-PET does not require visual recognition of anatomic layers and potentially could easily be taught to nonsurgeon physicians who perform peritoneal access.

Key Words: Peritoneal access, Laparoscopic, Cameraless, EndoTIP.

INTRODUCTION

The insertion of a telescope and working ports into the peritoneal cavity is required to begin any laparoscopic surgical procedure. These ports must be precisely placed in positions that minimize the risk of injury and allow visibility and instrument access to the operative site. Despite significant advances in laparoscopic instrumentation and techniques, injury to intraabdominal structures remains a potentially serious complication of obtaining peritoneal access. The estimated complication rate associated with laparoscopic access is 0.01% to 1.00%.[1–4] Complications described in several publications include injury to abdominal viscera, major and minor blood vessel damage, air embolus, and postoperative hernias. Although these complications are uncommon, they are a significant cause of the morbidity associated with laparoscopic surgery.[2,4]

Various techniques to achieve peritoneal access and capnoperitoneum have been described since Jacobeus first reported human laparoscopy in 1910.[5] These include the Veress-capnoperitoneum trocar,[6] the open (Hasson) technique,[7] direct trocar insertion without prior capnoperitoneum,[8] use of shielded retractable trocars,[9] optical Veress needle,[10] optical trocars,[11] radially expanding trocars,[12] and a reusable, visual access cannula with and without prior insufflation.[13,14] Surgeon preference varies widely depending on training, experience, bias, and regional and interdisciplinary variability.[15] Currently, consensus on the optimal technique is lacking.

Ternamian first described using the endoscopic threaded imaging port (EndoTIP) in 1996.[13] The EndoTIP system consists of a reusable, metal, threaded, trocarless visual-access cannula available in 6 mm and 11 mm sizes. The

Department of Urology, Dalhousie University, Halifax, NS, Canada (Drs. Carlson, Rendon).

Velomedix, Inc., Menlo Park, CA, (Drs. Tully, Rajguru, Burnett).

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Address correspondence to: Ricardo Rendon, Department of Urology, Dalhousie University. Fifth Floor – 5015 Centennial Building, QEII Health Sciences Centre VG Site, Halifax, NS B3H2Y9, Canada. Telephone: (902) 473 6570. Fax: (902) 492 2437, E-mail: rrendon@dal.ca.

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original technique uses the Veress needle to obtain capnoperitoneum, followed by a scalpel incision made in the anterior rectus fascia. The EndoTIP is then rotated clockwise around a fixed 0° lens to enter the abdomen under direct vision. The clockwise rotation of the cannula causes the external threads to bluntly dissect and lift the layers of the abdominal wall, thus requiring minimal axial pressure toward the abdominal viscera and major vessels. The spreading of tissues allows the muscle layers to fall back into place and negates the need to close the fascia after cannula removal.[14]

Hickey et al.[14] reported a novel technique using the EndoTIP cannula without prior peritoneal insufflation or making an incision into the anterior rectus fascia. Successful peritoneal entry with no reported adverse outcomes was obtained in all 165 patients undergoing laparoscopic urological surgery. Although time to peritoneal entry was not measured in all patients, when it was measured it was consistently < 1 min.

A critical safety component of direct visualization techniques, including optical trocars and the EndoTIP cannula is the surgeon's ability to identify the various layers of the abdominal wall and the peritoneal membrane when they appear. A peritoneal entry technique that is safe and effective and does not rely on direct visualization could shorten the learning curve for surgeons. Such a technique could also potentially be adopted by other physicians for a variety of nonsurgical indications, including catheter placement for peritoneal dialysis, peritoneal lavage for therapeutic hypothermia/rewarming, intraperitoneal chemotherapy, or diagnostic peritoneal lavage.

We report a series of upper-abdominal laparoscopic urologic surgeries that used the EndoTIP cannula and a novel cameraless fluid-based peritoneal entry indication technique for laparoscopic surgical access (C-PET). To our knowledge, this technique has not been previously reported in the literature.

PATIENTS AND METHODS

Study Sample

The entire series consisted of consecutive patients who underwent upper-abdominal laparoscopic urologic surgery performed by a single surgeon (RAR) at the Queen Elizabeth II Health Sciences Centre in Halifax, Nova Scotia, Canada, between January 2009 and June 2010. The study was approved by our local research ethics committee and informed consent was obtained from all patients. A database was used to prospectively collect patient demographics (age, sex, height, weight, body mass index [BMI], prior abdominal surgeries) and details about the procedures (type of surgery, time to peritoneal entry, number of turns required after peritoneal access detection, successful peritoneal entry, complications).

Technique

C-PET was used to obtain peritoneal access. With the patient in the 45° lateral decubitus position, a 1.0-cm transverse skin incision was made in the desired location. In patients with prior abdominal surgery, entry location was adjusted to a site approximately 10cm away from the existing scar. The reducer and valve of the 10-mm EndoTIP were removed, and the metal cannula was introduced through the skin incision and gently rotated until it was secured in the subcutaneous tissue **(Figures 1 and 2)**. Once the cannula had been engaged by the most superficial fascia of the abdominal external oblique muscle (easily felt by the operator when the tip of the cannula becomes fixed instead of mobile), the cannula was then filled with 20cc of sterile water **(Figure 3)**. With gentle axial pressure, the cannula was rotated clockwise toward the peritoneum. Although intraperitoneal pressure is slightly negative, to ensure the EndoTIP cannula was not pressed against intraperitoneal contents thereby obstruct-

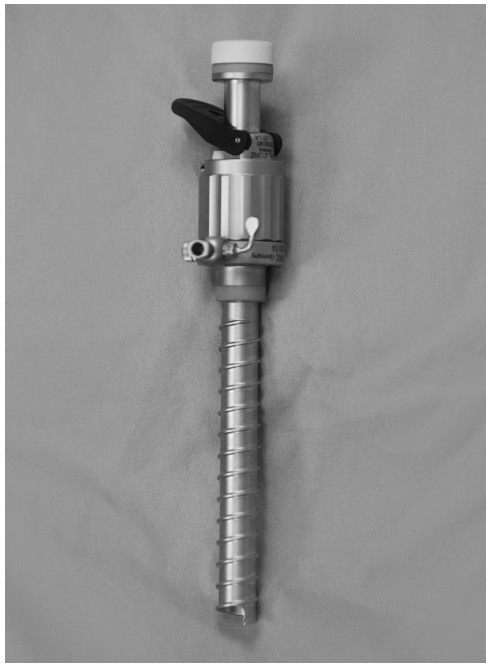

Figure 1. The 10 mm EndoTIP trocar with introducer and valve still in place.

Figure 2. The cannula of the 10 mm EndoTIP trocar is gently rotated until secured in the subcutaneous and superficial abdominal wall tissues.

Figure 3. The cannula is filled with 20cc of sterile saline.

ing the flow of water, gentle retraction on the cannula was applied after each completed 360° rotation. Because the threads of the EndoTIP are firmly engaged in the muscle layer, this gentle retraction effectively lifts the fascia and peritoneal membrane, thereby negating the need for additional external retractors. Peritoneal entry is detected when the water briskly empties from the cannula into the abdominal cavity **(Figure 4)**. An additional 90° clockwise rotation was applied while maintaining retraction to ensure the tip of the cannula was completely inside the peritoneal cavity. The reducer and valve were then replaced inside the cannula and insufflation initiated.

RESULTS

A total of 99 consecutive cases were examined in this study. All surgeries were performed using C-PET and the

Figure 4. The cannula is rotated clockwise through the abdominal wall until the saline briskly empties into the abdominal cavity, indicating peritoneal entry.

Table 1.
Procedures Performed During Study Period

Procedure	Number
Partial nephrectomy	55
Radical nephrectomy	20
Pyeloplasty	11
Nephroureterectomy	7
Adrenalectomy	4
Marsupialization renal cyst	2

10-mm port. The types of procedures performed are outlined in **Table 1**. Of the 99 patients enrolled in the study, 45 were female, 54 were male, and the mean age was 58.8 y (range, 23 to 87). Twenty-five patients (25.3%) had previous abdominal surgery. The mean BMI of the patients was 31.0 kg/m^2 (range, 18.5 to 62.0).

Successful entry into the abdomen using C-PET and subsequent capnoperitoneum was achieved in 90 (90.9%) of the patients. No trocar-related injuries or other injuries associated with peritoneal access were noted in any of these patients. No problems with gas leaks at the primary access port occurred. The mean time from incision to confirmed peritoneal access was 21.4 s (range, 12 to 65). Of the 9 instances in which successful peritoneal entry was not achieved using C-PET, 6 occurred in the first 20 cases and only 3 occurred in the final 79 cases. With the use of a camera in the EndoTIP cannula, access was obtained in all 9 failures. Patient characteristics between successful and failed C-PET entry are compared in **Table 2**. The only significant difference was noted in patient age, where the

Table 2.
Patient Characteristics Compared Between Successful and Failed C-PET Entry (n=99)

	Successful C-PET[a] Entry	Failed C-PET[a] Entry
Number of patients	90	9
-Men, no. (%)	49 (54%)	5 (56%)
-Women, no. (%)	41 (46%)	4 (44%)
Mean age (years)	60.1[b]	48.9
Body mass index (kg/m^2)	30.9[b]	32.0
Patients with prior abdominal surgery	24	1

[a]C-PET = cameraless fluid-based peritoneal entry indication technique for laparoscopic surgical access.

[b]Values for the entire sample of 99 pts.

mean age was 60.1 y in successful entry compared with 48.9 y in failed entry.

DISCUSSION

Indications for abdominal laparoscopic procedures are increasing for a variety of surgical disciplines. Despite improvements in technique and equipment, potentially avoidable intraabdominal injuries associated with initial trocar placement and obtaining capnoperitoneum still occur.[2] The ideal method of peritoneal entry for laparoscopic surgery should be effective, timely, easy to learn, safe, and reproducible in various patient populations. Currently, no consensus as to the optimal method exists among surgeons or surgical disciplines.[15]

The EndoTIP cannula, which includes a 0° lens for direct visualization, has been shown to be a safe and effective instrument to obtain peritoneal access for laparoscopic surgery with and without prior insufflation.[13,14] The EndoTIP cannula is designed to function like an Archimedes screw, lifting the abdominal wall with no downward vector.[2] This is an important characteristic for the C-PET entry technique, as it allows fluid to briskly empty from the cannula immediately upon entry into the peritoneal cavity, with minimal risk of injury to underlying structures. In this series, we did not have any injuries to intraabdominal structures.

In 9 cases, the peritoneum was not successfully entered using C-PET. Two factors contributing to the failures were identified. First, a learning curve was associated with this new technique, as 6 of the 9 failures occurred in the initial 20 surgeries. In the final 79 cases, only 3 failures occurred. Second, patients who did not have successful access by C-PET were younger and had thicker/stronger transversus abdominus fascia with more muscle mass. The average age of patients who had failed access was 48.9 y versus 60.1 y in patients with successful access. It was learned that these younger patients often required increased axial pressure to penetrate the transversus abdominus fascia. The surgeries for these patients were completed safely using direct visualization with a 0° camera lens. However, we were not able to quantify this perceived increased thickness/strength of the transversus abdominus fascia with the measured variables.

The C-PET proved versatile throughout a varied patient population. Our institution generally services an overweight population, and the average BMI in this series was 31.0 kg/m^2. The BMI of patients who had failed access was 32.0 kg/m^2 compared with 30.9 kg/m^2 in patients with successful access. Our technique was successful in 93% (40/43) of obese patients (BMI, 30 kg/m^2 to 40 kg/m^2) and 80% (4/5) of morbidly obese patients (BMI $>$ 40 kg/m^2). These results are consistent with previous reports of the use of the EndoTIP cannula in the obese population.[14,16]

Twenty-five patients in this study had previous abdominal surgery, yet this accounted for only 1 of 9 failures. Prior abdominal surgery and the presence of adhesions did not prevent successful use of the C-PET. Several surgeons have reported using an open technique when intraabdominal adhesions are suspected. However, disadvantages such as air-leak, increased access times, larger incisions in obese patients with increased wound infection rates are associated with open techniques.[17] Also, Paulter et al.[18] reported that preoperative assessment of risk factors did not effectively predict the presence of intraabdominal adhesions.

C-PET utilizes fluid to detect peritoneal entry, unlike other techniques that are completely blind (Veress) or require visual recognition (open approach or optical trocars). This safe and timely technique does not require visual recognition of anatomic landmarks and could potentially be utilized by nonsurgeon physicians for a variety of indications. For example, peritoneal catheter placement by nephrologists is commonplace for peritoneal dialysis, and critical care practitioners use peritoneal lavage for treatment of hypothermia and hyperthermia.[19,20] New research is exploring therapeutic hypothermia after acute myocardial infarction to reduce the size of cardiac infarct, which conceivably could utilize peritoneal lavage for efficient cooling.[21] Therapeutic and diagnostic procedures requir-

ing peritoneal entry may benefit from this simple method, and further research could examine effectiveness of this technique in the nonsurgeon's hands. We hypothesize that C-PET could be more easily taught to nonsurgeon physicians, because it does not require visual recognition of anatomic landmarks within the abdominal wall.

The limitations of this study include the relatively small number of patients and that this is a single-surgeon series. It is difficult to remove the "expert factor" when popularizing the use of a novel surgical technique. Nonetheless, at our institution, this fluid-based-entry-indication technique has replaced all other entry techniques for laparoscopic upper abdominal urological surgery.

CONCLUSION

Overall, the cameraless, fluid-based peritoneal entry indication technique using the EndoTIP system is simple, safe, timely, and effective for gaining peritoneal access for laparoscopic urological surgeries. The EndoTIP cannula is available in 6 mm and 11 mm sizes, requires no sharpening, is easy to maintain, and is reusable. In the current study, and this technique proved effective and produced no complications across a wide variety of patients, including the obese and those who had had previous surgery. Furthermore, the C-PET technique does not require visual recognition of anatomic layers and potentially could be taught easily to nonsurgeon physicians who perform peritoneal access.

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